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Contributions to the knowledge of amphibians and reptiles from Volta Grande do Xingu, northern Brazil

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Abstract

The region of Volta Grande do Xingu River, in the state of Pará, presents several kinds of land use ranging from extensive cattle farming to agroforestry, and deforestation. Currently, the Belo Monte Hydroelectric Power Plant affects the region. We present a checklist of amphibians and reptiles of the region and discuss information regarding the spatial distribution of the assemblies based on results of Environmental Programmes conducted in the area. We listed 109 amphibian (Anura, Caudata, and Gymnophiona) and 150 reptile (Squamata, Testudines, and Crocodylia) species. The regional species richness is still considered underestimated, considering the taxonomic uncertainty, complexity and cryptic diversity of various species, as observed in other regions of the Amazon biome. Efforts for scientific collection and studies related to integrative taxonomy are needed to elucidate uncertainties and increase levels of knowledge of the local diversity.

Keywords: herpetofauna, monitoring, Amazonia, Belo Monte.

Contribuições para o conhecimento de anfíbios e répteis da Volta Grande do Xingu, norte do Brasil

Resumo

A região da Volta Grande no Rio Xingu, localizada no estado do Pará, apresenta várias frentes de exploração que vão desde a criação animal até área de cultivo, resultando no desmatamento de fragmentos florestais. Atualmente a região está sendo impactada pela implantação da Usina Hidrelétrica de Belo Monte. A partir de dados obtidos através dos Programas de Monitoramento Ambiental realizados na área de influência da UHE Belo Monte, apresentamos uma listagem das espécies de anfíbios e répteis, com comentários sobre a distribuição espacial das assembleias. Foram catalogados 109 espécies de anfíbios (Anura, Caudata e Gymnophiona) e 150 de répteis (Squamata, Testudines e Crocodylia). Considerando as incertezas taxonômicas, a complexidade e a diversidade críptica de várias espécies, a riqueza regional ainda continua subestimada, assim como observado em outras regiões da Amazônia. Esforços direcionados ao aproveitamento científico e estudos que contemplem a taxonomia integrativa são necessários para elucidar as incertezas e aumentar o nível de conhecimento sobre a diversidade da região.

Palavras-chave: herpetofauna, monitoramento, Amazônia, Belo Monte.

1. Introduction

Amazonia is the largest tropical rainforest in the world and provides important ecosystem services as well high biodiversity and climate regulation (Coe et al., 2013). Azevedo-Ramos and Galatti (2002) presented a survey of information on amphibian richness in the Brazilian Amazon, estimating a minimum of 163 species. Ávila-Pires et al. (2007) report the occurrence of 232 species of amphibians and 273 species of reptiles. This richness is underestimated considering the taxonomic problems (Funk et al., 2011), the recent descriptions of species (e.g. Sturaro and Peloso, 2014) and taxonomic revisions (e.g. Maciel and Hoogmoed, 2011; Brcko et al., 2013).

There is a lack of information of the current status of the Brazilian Amazonian Herpetofauna due to dispersed and unpublished data (Azevedo-Ramos and Galatti, 2002; Ávila-Pires et al., 2007). Knowledge has increased in the last 10 years based on studies conducted in the Manaus region (*e.g.* Lima et al., 2006, Menin et al., 2007, Vitt et al., 2008), State of Pará (*e.g.* Frota, 2004; Caldwell and Araújo, 2005; Frota et al., 2005; Prudente and Santos-Costa, 2005; Ávila-Pires et al., 2009; Maschio et al., 2009; Mendes-Pinto and Tello, 2010; Bitar et al., 2011; Frota et al., 2011; Mendes-Pinto and Souza, 2011), State of Rondônia (*e.g.* Bernarde and Abe, 2006; Bernarde, 2007; Bernarde and Macedo, 2008; Macedo et al., 2008; Avila-Pires et al., 2009) and in the State of Acre (*e.g.* Souza et al., 2003; Souza et al., 2008; Bernarde et al., 2011).

Faunal inventories are important tools for Amazonian conservation, since biological surveys stimulate the discovery of new species, revealing endemic areas and the current levels of biodiversity (França and Venâncio, 2010). The production of scientific knowledge resulting from activities related to environmental projects when carried out by specialist teams is one of the most important ways to mitigate the impacts generated by impactful project implementation (Vaz-Silva, 2009). The knowledge generated is essential for making decisions and the establishment of conservation policies.

The aim of this paper is to present the current status of knowledge of the amphibians and reptiles from Volta Grande do Xingu, in the state of Pará, based on information obtained after three years of the Faunal Rescue Programme and two years of the Environmental Monitoring Programme in the region of influence of the Belo Monte Hydroelectric Power Plant (UHE Belo Monte). Also discussed will be information concerning the spatial distribution of the assemblies in the monitored sites.

2. Material and Methods

The UHE Belo Monte is located in Volta Grande do Xingu, on the right bank tributary of the Amazon River, state of Pará, northern Brazil (Figure 1). The Hydroelectric project consists of the dam, reservoir, water intake and power house, occupying part of Altamira, Vitória do Xingu, Anapu, and Brasil Novo municipalities. The basin of Rio Xingu, with a total area of 509,000 km^2, has not suffered greatly from deforestation. The area of the UHE Belo Monte, due to its proximity to the regional centre of Altamira city and

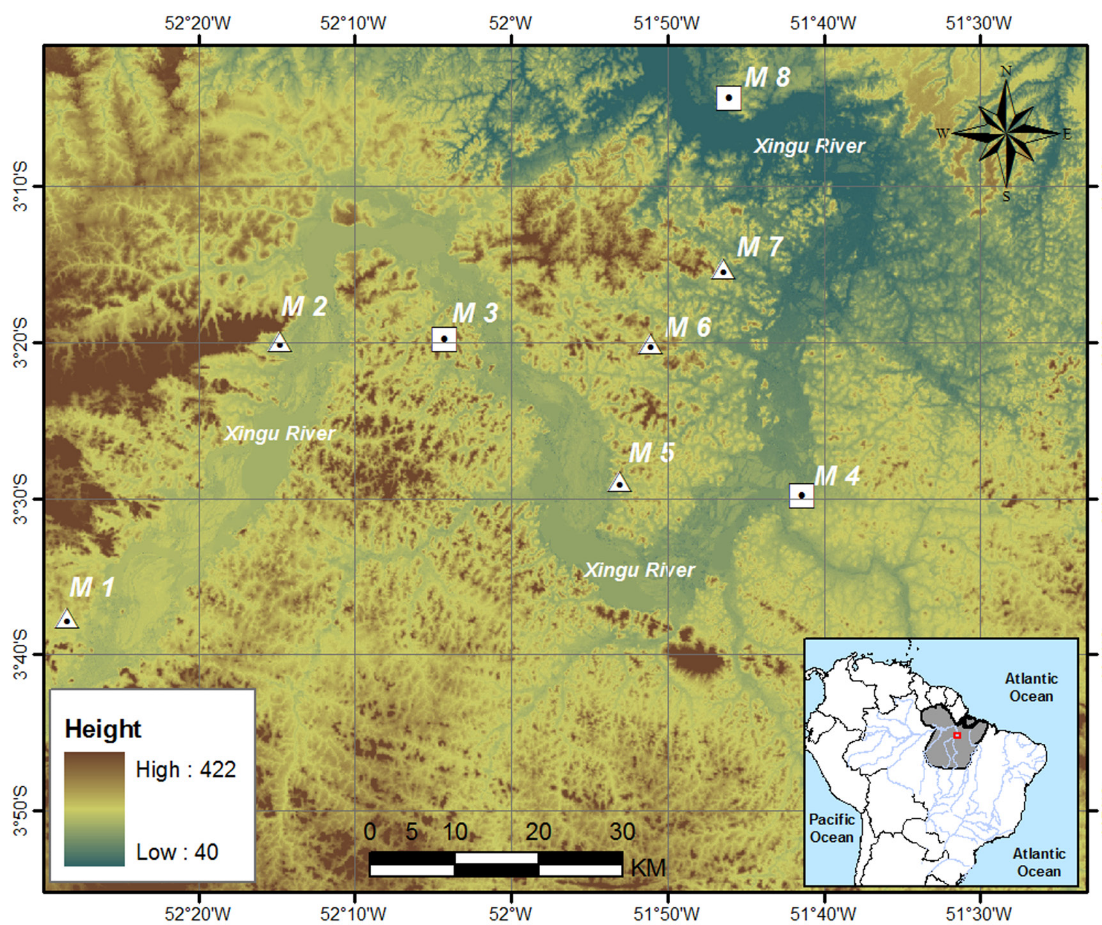

Figure 1. Hypsometric map showing the location of the study site and the altitude variation (height), Volta Grande do Xingu River. M1 – M8 = modules RAPELD 1 to 8.

highway BR-230 (Transamazônica), has many uses ranging from extensive cattle farming to agroforestry, and natural forest remains (Souza Junior et al., 2006). The vegetation types in the region are the Floresta Ombrófila Densa (Dense Rain Forest), Floresta Ombrófila Densa Aluvial (Alluvial Rain Forest), Open Rain Forest with Palm Trees and Vines (Floresta Ombrófila Aberta com Cipós e Palmeiras) (Salomão et al., 2007).

We present the results of the Environmental Impact Study (EIA-RIMA) (Leme Engenharia, 2009) and preliminary data of the Environmental Monitoring Programmes conducted during the installation of the Belo Monte Hydroelectric Power Plant (Faunal Rescue Programme and Environmental Monitoring Programme of Herpetofauna). We compare the presented results with the regional knowledge based on published papers (Caldwell and Araújo, 2005; Oliveira et al., 2013) to produce the checklist of the species.

The EIA-RIMA considered three field expeditions between 2000-2001 and 2007-2008 (Leme Engenharia, 2009). The Faunal Rescue Programme contemplated management actions implemented during the suppression of vegetation in the area of direct influence of the UHE Belo Monte from June 2011 to April 2014. We considered only standardised data from the Environmental Monitoring Programme of Herpetofauna for analyses. The analyses grouped results from five expeditions (2011 to 2014), with samples obtained from eight sampling sites (modules M1 to M8), considered as the RAPELD methodology (Magnusson et al., 2005, 2013). Voucher specimens are housed at the Museu Paraense Emílio Goeldi (Belém), Museu Nacional (Rio de Janeiro), Museu de Zoologia da Universidade de São Paulo (São Paulo), and at the Coleção Herpetológica da Universidade Federal de Goiás (Goiânia).

We calculated the dissimilarity matrix for the modules (M1 to M8) considering the abundance of species, using the coefficient Bray Curtis. Cluster analysis was performed using the method of unweighted average linkage (UPGMA) from the Bray-Curtis dissimilarity matrix using Past software (Hammer et al., 2001). Diversity between sampling sites was compared by Hill's series (Hill, 1973): $N_a=(p_1^a+p_2^a+ \ldots + p_n^a)^{(1/(1-a))}$. Where: N_a is the diversity index value by parameter *a*; *n* is the number of species; and, p_i proportional abundance of the species *i*. Hill's series was calculated by R software 3.0.1 (R Development Core Team, 2013), *vegan* package (Oksanen et al., 2013). The taxonomic arrangement used in the checklist followed Pyron et al. (2013) and Frost (2014).

3. Results and Discussion

The cumulative data of the Environmental Programmes from earlier times before the operation of the UHE Belo Monte resulted in a checklist of 109 amphibian and 150 reptile species (Table 1). Volta Grande do Xingu corresponds to a region with few Herpetofaunal inventories. Some ecological, population and natural history studies of the chelonians, amphibians and lizards have been conducted in the region (Caldwell and Lopez, 1989; Howland et al., 1990; Vitt and Blackburn, 1991; Vitt and Breitenbach, 1993; Vitt et al., 1997; Vitt and Zani 1998; Pearse et al., 2006). Caldwell and Araújo (2005) reported the occurrence of 40 species of amphibians from Cachoeira Juruá. Oliveira et al. (2013) reported the occurrence of 30 species of amphibians, 13 snakes and 7 lizard species from the municipality of Brasil Novo municipality. Knispel and Barros (2009) reported the occurrence of 15 species of amphibians for the urban area of Altamira. Maciel et al. (2013) reported the occurrence of *Siphonops anullatus* in the municipality of Senador Jose Porfírio, showing the incipient knowledge of the local herpetofauna.

According to the EIA-RIMA, 60 amphibian and 87 reptile species are found in the region of the UHE Belo Monte, and this richness can reach 68 amphibians and 118 reptiles considering the regional knowledge. The increased sampling effort provided by Environmental Monitoring Programmes from the UHE Belo Monte resulted in the increase of 111 species (48 amphibians and 63 reptiles, including those with open nomenclature) to the Herpetofauna checklist (Table 1). The cumulative data show a high diversity compared to other sites of the Amazonian biome (17 amphibian and 40 reptilian at Cacoal – Turci and Bernarde, 2008; 56 amphibian and 53 reptilian species at Boca do Acre, state of Amazonas – França and Venâncio, 2010; 83 amphibian and 79 reptilian at Reserva Extrativista Riozinho da Liberdade – Bernarde et al., 2011; 35 amphibian and 59 reptilian species at Floresta Nacional do Trairão – Mendes-Pinto and Souza, 2011; 59 reptilian species at Barcarena – Silva et al., 2011; 38 reptilian species at Alto Alegre dos Parecis – Ferrão et al., 2012; 71 amphibian species at Carajás region – Pinheiro et al., 2012; and 46 amphibian and 38 reptilian species at Reserva Extrativista do rio Gregório – Pantoja and Fraga, 2012).

New records in the state (*e.g.* Frota and Vaz-Silva, 2013; Camera and Krinski, 2014) evidence the incipience of knowledge in the regional context due to the lack of sampling. The checklist presented represents an increase in regional knowledge. The records of sympatric Centrolenidae species (this study) are important considering the ecological aspects of the species. Centrolenids are considered specialists in the use of the environment, occurring on the banks of streams and waterfalls in woody vegetation where they lay their egg masses (Cisneros-Heredia and Mcdiarmid, 2007). Considering the impact resulting from the implementation of the UHE Belo Monte, which will result in the suppression of habitats associated with the occupation of Centrolenids, monitoring of these populations is an important factor in the continuity of the Monitoring Programme.

Recent studies evidence that species of this family are distributed throughout the Amazon basin, as reported for *Cochranella adenocheira* by Toledo et al. (2009) and Oliveira et al. (2012), *Hyalinobatrachium iaspidiensis* by Yanez-Muñoz et al. (2009), *Hyalinobatrachium cappellei* by Simões et al. (2012), *Hyalinobatrachium caslesvilai* by Cisneros-Heredia et al. (2010). Endemics restricted in the biome can be attributed to the lack of sampling. Other

Table 1. Checklist of amphibians and reptiles from Volta Grande do Xingu, state of Pará, Brazil. EIA-RIMA = Environmental Impact Study; FRF = Faunal Rescue Programme; MEP = Monitoring Environmental Programme.

Taxon	EIA-RIMA	FRP	MEP
Class Amphibia			
Family Bufonidae			
Amazophrynella cf. *bokermanni* (Izecksohn, 1994 "1993")	X		X
Rhaebo guttatus (Schneider, 1799)	X	X	X
Rhinella castaneotica (Caldwell, 1991)		X	X
Rhinella major (Muller and Helmich, 1936)	X	X	X
Rhinella margaritifera (Laurenti, 1768)	X		X
Rhinella marina (Linnaeus, 1758)	X	X	
Family Ceratophryidae			
Ceratophrys cornuta (Linnaeus, 1758)	X	X	X
Family Odontophrynidae			
Proceratophrys sp.	X	X	X
Famíly Leptodactylidae			
Adenomera cf. *andreae* (Müller, 1923)		X	X
Adenomera hylaedactyla (Cope, 1868)		X	X
Adenomera sp.	X		X
Leptodactylus knudseni Heyer, 1972		X	X
Leptodactylus leptodactyloides (Andersson, 1945)	X		X
Leptodactylus longirostris Boulenger, 1882		X	X
Leptodactylus macrosternum Miranda-Ribeiro, 1926	X		X
Leptodactylus mystaceus (Spix, 1824)	X	X	X
Leptodactylus paraensis Heyer, 2005	X	X	X
Leptodactylus pentadactylus (Laurenti, 1768)	X	X	X
Leptodactylus petersii (Steindachner, 1864)	X	X	X
Leptodactylus podicipinus (Cope, 1862)	X		X
Leptodactylus rhondomystax Boulenger, 1884	X	X	X
Leptodactylus stenodema Jiménez de la Espada, 1875		X	
Lithodytes lineatus (Schneider, 1799)	X	X	X
Engystomops petersi Jiménez de la Espada, 1872	X	X	X
Physalaemus ephippifer (Steindachner, 1864)	X	X	X
Physalaemus sp.			X
Family Strabomantidae			
Pristimantis aff. *ockendeni* (Boulenger, 1912)		X	X
Pristimantis fenestratus (Steindachner, 1864)	X	X	X
Pristimantis sp.		X	X
Pristimantis sp.1		X	X
Pristimantis sp.2		X	X
Family Hylidae			
Dendropsophus brevifrons (Duellmann and Crump, 1974)	X	X	X
Dendropsophus leucophyllatus (Beireis, 1783)	X	X	X
Dendropsophus melanargyreus (Cope, 1887)	X	X	X
Dendropsophus microcephalus (Cope, 1886)		X	X
Dendropsophus minutus (Peters, 1872)		X	X
Dendropsophus nanus (Boulenger, 1889)			X
Dendropsophus sp.		X	X
Dendropsophus sp.1	X		X
Dendropsophus sp.2	X		X
Dryaderces inframaculatus (Boulenger, 1882)		X	X
Hypsiboas albopunctatus (Spix, 1824)		X	

Table 1. Continued...

Taxon	EIA-RIMA	FRP	MEP
Hypsiboas boans (Linnaeus, 1758)	X	X	X
Hypsiboas calcaratus (Troschel, 1848)	X	X	X
Hypsiboas cf. lanciformis (Cope, 1871)		X	X
Hypsiboas cinerascens (Spix, 1824)	X	X	X
Hypsiboas fasciatus (Günther, 1858)	X		X
Hypsiboas geographicus (Spix, 1824)	X	X	X
Hypsiboas multifasciatus (Günther, 1859)	X	X	X
Hypsiboas raniceps Cope, 1862		X	X
Hypsiboas sp.		X	X
Osteocephalus leprieurii (Duméril and Bibron, 1841)	X	X	X
Osteocephalus oophagus Jungfer and Schiesari, 1995	X	X	
Osteocephalus sp.	X		
Osteocephalus taurinus Steindachner, 1862	X	X	X
Phyllomedusa bicolor (Boddaert, 1772)	X	X	X
Phyllomedusa hypochondrialis (Daudin, 1800)	X	X	X
Phyllomedusa tomopterna (Cope, 1868)		X	X
Phyllomedusa vaillantii Boulenger, 1882	X	X	X
Scinax aff. *proboscideus* (Brongersma, 1933)			X
Scinax aff. *rostratus* (Peters, 1863)			X
Scinax aff. *x-signatus* (Spix, 1824)	X		
Scinax boesemani (Goin, 1966)	X	X	X
Scinax cf. *cruentommus* (Duellman, 1972)	X	X	X
Scinax fuscomarginatus (Lutz, 1925)	X	X	X
Scinax garbei (Miranda-Ribeiro, 1926)	X	X	X
Scinax nebulosus (Spix, 1824)	X	X	X
Scinax rostratus (Peters, 1863)			X
Scinax ruber (Laurenti, 1758)	X		X
Scinax sp. (*S. ruber* clade)			X
Scinax sp.1 (*S. ruber* clade)			X
Sphaenorhyncus lacteus (Daudin, 1800)			X
Trachycephalus resifinictrix (Goeldi, 1907)	X	X	
Trachycephalus typhonius (Linnaeus, 1758)	X	X	X
Family Alophrynidae			
Alophryne ruthveni Gaige, 1926	X	X	X
Family Centrolenidae			
Cochranella adenocheira Harvey and Nooan, 2005			X
Cochranella sp.			X
Hyalinobatrachium cappellei van Lidth de Jeude, 1904			X
Hyalinobatrachium iaspidiensis (Ayarzaqüena, 1992)		X	
Hyalinobatrachium sp.	X	X	X
Hyalinobatrachium sp.1			X
Vitreorana ritae (Lutz, 1952)			X
Family Aromobatidae			
Allobates crombiei (Morales, 2002 "2000")	X	X	X
Allobates femoralis (Boulenger, 1884 "1883")	X	X	X
Allobates sp.		X	X
Allobates sp.1			X
Allobates sp.2			X
Family Pipidae			
Pipa arrabali Izecksohn, 1976			X

Table 1. Continued...

Taxon	EIA-RIMA	FRP	MEP
Pipa pipa (Linnaeus, 1758)		X	X
Family Dendrobatidae			
Adelphobates castaneoticus (Caldwell and Myers, 1990)	X	X	X
Adelphobates galactonotus (Steindachner, 1864)	X	X	X
Ameerega hahneli (Boulenger, 1884)	X		X
Ranitomeya amazonica (Schulte, 1999)			X
Family Microhylidae			
Chiasmocleis hudsoni Parker, 1940	X	X	
Chiasmocleis sp.	X		
Ctenophryne geayi Mocguard, 1904	X	X	X
Elachistocleis cf. *carvalhoi* Caramaschi, 2010	X	X	X
Hamptophryne boliviana (Parker, 1927)	X		
Order Urodela			
Family Plethodontidae			
Bolitoglossa paraensis (Unterstein, 1930)		X	X
Bolitoglossa tapajonica Brcko et al., 2013		X	
Order Gymnophiona			
Family Caecillidae			
Caecilia gracilis Shaw, 1002		X	X
Caecilia tentaculata Linnaeus, 1758		X	
Family Siphonopidae			
Microcaecilia sp.	X		
Micricaecilia taylori Nussbaum and Hoogmoed, 1979		X	
Siphonops annulatus (Mikan, 1820)			X
Family Typhlonectidae			
Atretochoana eiselti (Taylor, 1968)		X	
Potomotyphlus kaupii (Berthold, 1859)		X	
Typhlonectes compressicauda (Duméril and Bibron, 1841)		X	
Class Reptilia			
Order Squamata			
Suborder Amphisbaenia			
Family Amphisbaenidae			
Amphisbaena alba Linnaeus, 1758		X	
Amphisbaena amazonica Vanzolini, 1951		X	
Amphisbaena brasiliana (Gray, 1865)		X	
Amphisbaena mitchelli Procter, 1923		X	X
Suborder Sauria			
Family Gekkonidae			
Hemidactylus mabouia (Moreau de Jonnès, 1818)		X	
Family Phyllodactylidae			
Thecadactylus rapicauda (Houttuyn, 1782)	X	X	X
Family Sphaerodactylidae			
Chatogeckko amazonicus (Andersson, 1918)	X	X	X
Gonatodes hasemani Griffin, 1917	X	X	X
Gonatodes humeralis (Guichenot, 1855)	X	X	X
Gonatodes nascimentoi Sturaro and Ávila-Pires, 2011			X
Gonatodes eladioi Nascimento, Ávila-Pires and Cunha, 1987		X	
Lepidoblepharis heyerorum Vanzolini, 1978	X	X	X
Pseudogonatodes guianensis Parker, 1935	X	X	X
Family Gymnophthalmidae			

Table 1. Continued...

Taxon	EIA-RIMA	FRP	MEP
Alopoglossus angulatus (Linnaeus, 1758)	X	X	X
Arthrosaura kockii (Lidth de Jeude, 1904)	X		X
Arthrosaura reticulata (O'Shaughnessy, 1881)	X	X	X
Colobosaura modesta (Reinhardt and Luetken, 1862)		X	
Cercosaura argulus Peters, 1863	X	X	
Cercosaura ocellata Wagler, 1830	X	X	X
Leposama osvaldoi Ávila-Pires, 1995		X	X
Leposoma percarinatum (Müller, 1923)	X	X	X
Leposoma sp.			X
Leposoma sp.1			X
Neusticurus rudis Boulenger, 1900			X
Potamipes ecpleopus (Cope, 1876)		X	X
Ptychoglossus brevifrontalis Boulenger, 1912	X	X	
Tretioscincus agilis Ruthven, 1916	X		X
Family Iguanidae			
Iguana iguana (Linnaeus, 1758)	X	X	X
Family Dactyloidae			
Anolis fuscoauratus D'Orbigny, 1837	X	X	X
Anolis ortonii Cope, 1868	X	X	X
Anolis punctatus Daudin, 1802	X	X	
Anolis sp.		X	X
Anolis trachyderma Cope, 1876	X	X	X
Fmily Leiosauridae			
Enyalius leechi (Boulenger, 1885)		X	X
Family Polychrotidae			
Polychrus marmoratus (Linnaeus, 1758)	X	X	X
Family Scincidae			
Copeoglossum nigropunctatum (Spix, 1825)	X	X	X
Family Tropiduridae			
Plica plica (Linnaeus, 1758)	X	X	X
Plica umbra (Linnaeus, 1758)	X	X	X
Uranocentron azureum (Linnaeus, 1758)		X	
Uranoscondon superciliosus (Linnaeus, 1758)	X	X	X
Family Teiidae			
Ameiva ameiva (Linnaeus, 1758)	X	X	X
Cnemidophorus cryptus Cole and Dessauer, 1993	X	X	X
Crocodilurus amazonicus Spix, 1825			X
Kentropys calcarata Spix, 1825	X	X	X
Kentropyx altamazonica (Cope, 1876)		X	X
Tupinambis teguixin (Linnaeus, 1758)	X	X	X
Subordem Serpentes			
Family Aniliidae			
Anilius scytale (Linnaeus, 1758)		X	X
Family Anomalepididae			
Liotyphlops ternetzi (Boulenger, 1896)		X	
Family Boidae			
Boa constrictor (Linnaeus, 1758)	X	X	X
Corallus caninus (Linnaeus, 1758)	X	X	
Corallus hortulanus (Linnaeus, 1758)	X	X	X
Epicrates cenchria (Linnaeus, 1758)	X	X	X

Table 1. Continued...

Taxon	EIA-RIMA	FRP	MEP
Eunectes murinus (Linnaeus, 1758)	X	X	
Family Colubridae			
Apostolepis nigrolineata (Peters, 1896)		X	X
Apostolepis pymi Boulenger, 1903		X	
Atractus albuquerquei Cunha and Nascimento, 1983	X	X	
Atractus elaps (Günther, 1858)		X	
Atractus latifrons (Günther, 1868)		X	
Atractus schach (Boie, 1827)	X	X	
Atractus snethlageae Cunha and Nascimento, 1983	X	X	X
Atractus sp.		X	
Chironius bicarinatus (Wied, 1820)		X	
Chironius carinatus (Linnaeus, 1758)		X	X
Chironius exoletus (Linnaeus, 1758)		X	X
Chironius fuscus (Linnaeus, 1758)	X	X	X
Chironius multiventris Schmidt and Walker, 1943	X	X	X
Chironius scurrulus (Wagler, 1824)	X	X	X
Clelia cleia (Daudin, 1803)	X	X	
Clelia plumbea (Wied, 1820)			X
Dendrophidion dendrophis (Schlegel, 1837)		X	X
Dipsas catesbyi (Sentzen, 1796)	X	X	X
Dipsas indica Laurenti, 1768		X	X
Dipsas pavonina Schlegel, 1837		X	
Dipsas variegata (Duméril, Bibron and Duméril, 1854)		X	
Drepanoides anomalus (Jan, 1863)	X	X	X
Drymarchon corais (Boie, 1827)		X	
Drymoluber dichrous (Peters, 1863)		X	X
Erythrolamprus aesculapii (Linnaeus, 1766)		X	
Erythrolamprus breviceps (Cope, 1860)		X	
Erythrolamprus oligolepis (Boulenger, 1905)	X		
Erythrolamprus poecilogyrus (Wied, 1825)		X	
Erythrolamprus reginae (Linnaeus, 1758)	X		X
Erythrolamprus taeniogaster (Jan, 1863)		X	
Erythrolamprus typhlus (Linnaeus, 1758)	X	X	
Helicops angulatus (Linnaeus, 1758)	X	X	X
Helicops modestus Günther, 1861		X	
Hydrodynastes bicinctus (Herrmann, 1804)	X	X	
Hydrodynastes gigas (Duméril, Bibron and Duméril, 1854)		X	
Hydrops martii (Wagler, 1824)	X	X	
Hydrops triangularis (Wagler, 1824)		X	
Imantodes cenchoa (Linnaeus, 1758)	X	X	X
Imantodes lentiferus (Cope, 1894)		X	
Leptodeira annulata (Linnaeus, 1758)	X	X	X
Leptophis ahaetulla (Linnaeus, 1758)	X	X	X
Mastigodryas boddaerti (Sentzen, 1796)	X	X	X
Oxybelis aeneus (Wagler, 1824)	X	X	X
Oxybelis fulgidus (Daudin, 1803)		X	X
Oxyrhopus melanogenys (Tschudi, 1845)	X	X	X
Oxyrhopus petolarius Reuss, 1834		X	X
Oxyrhopus trigeminus Duméril, Bibron and Duméril, 1854	X	X	X
Philodryas argentea (Daudin, 1803)	X		X

Table 1. Continued...

Taxon	EIA-RIMA	FRP	MEP
Philodryas olfersii (Lichtenstein, 1823)		X	
Philodryas viridissima (Linnaeus, 1758)	X	X	
Pseudoboa coronata Schneider, 1801	X	X	X
Pseudoboa nigra (Duméril, Bibron and Duméril, 1854)		X	
Pseudoeryx plicatilis (Linnaeus, 1758)		X	
Pseustes sulphureus (Wagler, 1824)	X	X	
Pseutes poecilonotus (Peters, 1867)		X	
Rhinobotrium lentiginosum (Scopoli, 1785)		X	X
Sibon nebulatus (Linnaeus, 1758)	X	X	X
Siphlophis cervinus (Laurenti, 1768)	X	X	X
Siphlophis compressus (Daudin, 1803)	X	X	X
Siphlophis worontzowi (Prado, 1940)		X	
Spilotes pullatus (Linnaeus, 1758)	X	X	X
Taeniophallus brevirostris (Peters, 1863)	X	X	
Taeniophallus quadriocelatus Santos-Jr., Di-Bernardo and Lema, 2008		X	X
Tantilla melanocephala (Linnaeus, 1758)	X	X	X
Xenodon merremi (Wagler, 1824)		X	
Xenodon rabdocephalus (Wied, 1824)	X	X	
Xenodon severus (Linnaeus, 1758)	X	X	X
Xenopholis scalaris (Wucherer, 1861)	X	X	X
Family Elapidae			
Micrurus filiformis (Günther, 1859)		X	
Micrurus hemprichii (Jan, 1858)		X	X
Micrurus lemniscatus (Linnaeus, 1758)	X	X	X
Micrurus paraensis Cunha and Nascimento, 1973		X	X
Micrurus psyches (Daudin, 1803)		X	
Micrurus spixii Wagler, 1824	X	X	
Micrurus surinamensis (Cuvier, 1817)		X	X
Family Typhlopidae			
Typhlops brongersmianus Vanzolini, 1976		X	
Typhlops reticulatus (Linnaeus, 1758)	X	X	X
Family Leptotyphlopidae			
Siagonodon septemstriatus (Schneider, 1801)		X	
Trilepida macroleps (Peters, 1857)		X	X
Family Viperidae			
Bothrops bilineata (Wied, 1825)		X	
Bothrops taeniata (Wagner, 1824)		X	
Bothrops atrox (Linnaeus, 1758)	X	X	X
Lachesis muta (Linnaeus, 1766)	X	X	X
Order Crocodylia			
Family Alligatoridae			
Caiman crocodilus (Linnaeus, 1758)	X	X	X
Melanosuchus niger (Spix, 1825)	X		
Paleosuchus palpebrosus (Cuvier, 1807)	X		X
Paleosuchus trigonatus (Schneider, 1801)	X	X	X
Order Testudines			
Family Chelidae			
Mesoclemmys gibba (Schweigger, 1812)	X	X	X
Platemys platycephala (Schneider, 1792)	X	X	X

Table 1. Continued...

Taxon	EIA-RIMA	FRP	MEP
Family Geoemydidae			
Rhinoclemmys punctularia (Daudin, 1801)	X	X	X
Family Knosternidae			
Kinosternon scorpioidis (Linnaeus, 1766)	X	X	
Family Podocnemididae			
Peltocephalus dumerilianus (Schweigger, 1812)	X		
Podocnemis expansa (Schweigger, 1812)	X	X	
Podocnemis sextuberculata Cornalia, 1849	X		
Podocnemis unifilis Troschel, 1848	X	X	
Family Testudinidae			
Chelonoidis carbonarius (Spix, 1824)	X		X
Chelonoidis denticulatus (Linnaeus, 1766)	X		X

studies discuss aspects of reproductive behaviour and how sympatric species are ecologically segregated (Rojas-Morales and Escobar-Lasso, 2013). The genus *Pristimantis* and *Allobates* show a high cryptic diversity and other genus reveal the presence of taxonomic complex (for example, *Adenomera*, *Dendropsophus*, *Scinax*, *Osteocephalus*, and *Leposoma*). Some semi-fossorial species represent undescribed species, for example, for *Atractus* (P. Passos, pers. com.) and *Proceratophrys* (W. Vaz-Silva, pers. obs.). The record of rare gymnophiona *Atretochoana eiselti* reveals the biogeographic importance in the regional context.

The diversity profiles of amphibian assemblages (Figure 2) show that M5 present the highest richness with 68 species (*a*= 0), while M1 and M2 the poorest, with 45 and 46 species respectively. Considering the diversity, the amphibian assemblages are very similar, and as pointed out by Tóthmérész (1995) and Melo (2008), it is not possible to distinguish them using Hill's Series Diversity Profile. The high values of *a* parameter obtained by Hill's Profile give the evenness of the assemblages. Therefore, M2 and M8 present the less uniform species proportions, while the highest evenness was observed in M1 and M5.

Regarding reptile diversity, the assemblages are very similar. The highest richness is found in M6 with 50 species (Figure 3). On the other hand, M3 and M4 presented the least number of registered species, 33. The diversity profiles show that the less uniform assemblages are present in M3 and M4. The reptile assemblages are more susceptible to a low evenness index, giving the cryptic habitats of many species, which make them barely detectable, resulting in occasional registers.

According to Melo (2008), understanding the diversity of species in an area is fundamental for optimising management in relation to the activity of exploitation of low impact, resource conservation or for the restoration of degraded ecosystems. Despite showing similar phytophysiognomies, the modules are under the influence of several factors (e.g. the edge effect), due to the size and disposition of remains in the landscape. Edge and area effects are the most important factors that cause changes in fragmented communities (Nascimento and Laurance, 2006). Results of the diversity in the modules may be related to habitat characteristics (humidity, temperature, incorporation of litter, litter depth and changes in vegetation structure edge or lower strata of the forest margin) with the consequent availability of resources, as well as reflecting patterns of spatial distribution of species.

The cluster analysis of the amphibian assemblages generated two groups (Figure 4). The module M1 showed a more differentiated assemblage. Modules M5, M6 and M7 are located on the left bank of the Xingu River, and presented high values of abundance and richness. The results can be attributed to the similar characteristics between the sites. The other grouping is the modules on the right bank of the Xingu River, in addition to M2.

In relation to the reptile assemblage, the cluster analysis formed two clusters that are represented by modules present on opposite banks of the Xingu River (Figure 5). Reptile assemblages can be differentiated by the environmental attributes on each bank, or the river can be a barrier to the species. The similarity between the two banks is less between themselves than modules on the same bank. According to biogeographic hypothesis, rivers may play a major role in creating and maintaining high levels of species diversity in the tropics increasing the possibility of allopatric speciation (Gascon et al., 1998).

The regional species richness can still be considered underestimated, considering the taxonomic uncertainty, complexity and cryptic diversity of various species, as observed in other regions of the Amazon biome (see Padial and De La Riva, 2009; Funk et al., 2011; Jansen et al., 2011). Considering other experiences observed within hydroelectric projects, the impacts of biodiversity are irreversible mainly due to forest loss, leading to the loss of natural ecosystems (Fearnside, 2001). Our results represent the actual regional knowledge before the implementation of the UHE Belo Monte, and they are important for permitting future comparison after the operation of the power plant. Considering the high diversity of the region and the predicted impacts, we suggest that scientific collection should be prioritised for the production of scientific knowledge. Studies related to integrative taxonomy are

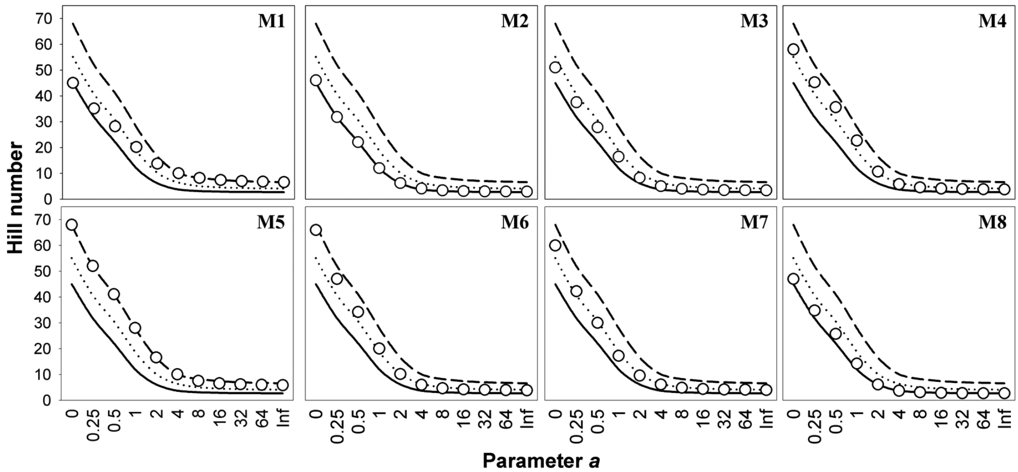

Figure 2. Profiles of assemblage diversity (for amphibians) in RAPELD modules. The three lines represent the maximum, average and minimum diversity values considering all modules. Empty circles represent the value of the Hill number for the module. M1 - M8 = Modules 1 to 8.

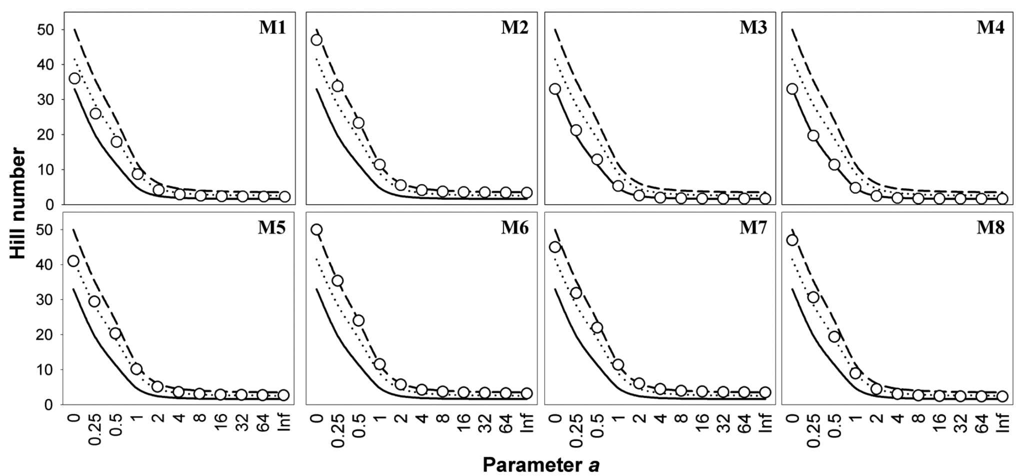

Figure 3. Profiles of assemblage diversity (for reptiles) in RAPELD modules. The three lines represent the maximum, average and minimum values diversity considering all modules. Empty circles represent the value of the Hill number for the module. M1 - M8 = Modules 1 to 8.

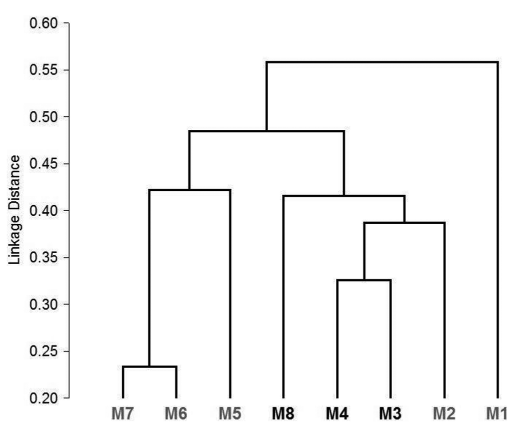

Figure 4. Cluster analyses of the amphibian assemblages in RAPELD modules. Modules in bold (M3, M4, M8) are located on the right bank of the Xingu river, and the others (M1, M2, M5, M6, M7) are located on the left bank.

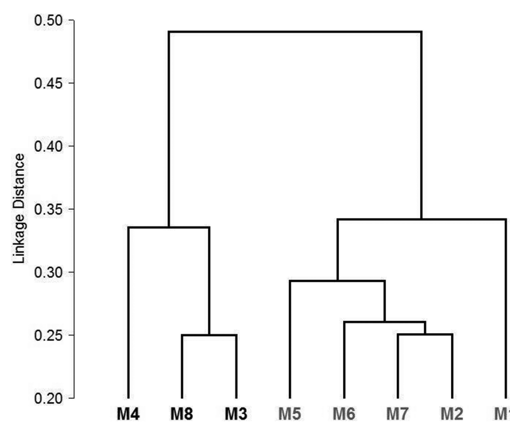

Figure 5. Cluster analyses of the reptiles assemblages in RAPELD modules. Modules in bold (M3, M4, M8) is located in the right bank of the Xingu river, and others (M1, M2, M5, M6, M7) is located in the left bank.

needed to elucidate the uncertainties and increase levels of local diversity.

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